PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Tray for Contacting Liquids and Gases

We, SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ N.V., a company organised under the Laws of the Netherlands of 30, Carel van Bylandtlaan, The Hague, the Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a tray for mounting in a column for contacting liquids and gases which is provided with at least one tubular liquid-gas contacting apparatus which is provided on one end with means for the supply of liquid and gas and on the other end with means for the discharge of liquid and gas and where within each apparatus the gas during the operation of the tray is in the continuous phase and where within each apparatus one or more parts are present which impart a rotary motion to the gas and the liquid.

The term gas is taken throughout this specification also to include vapour.

Tubular contacting apparatuses as described above have been proposed wherein during the operation of the tray, gas and liquid move in the same direction. Provision has been made for the atomization of the liquid for the purpose of increasing the rate of the operation, and the rotation of the gas is of great importance for the efficient separation of liquid from gas.

In industry, for example, in distilling in oil refineries very large quantities are often involved in the gas-liquid exchange processes. In these cases the use of tubular contacting apparatus as described above is very attractive, because high gas rates can be applied and in designing plant of this type it is of great importance to minimize the volume of the entire plant. This is because the cost of construction increases very considerably with increasing volume of the plant, mainly as a result of the heavier column and foundation required. Because of this it is favourable to make use of a plurality of tubular contacting apparatuses of a small diameter rather than using one contacting apparatus of a large diameter.

Moreover to attain a given separating efficiency the length of a tubular changer of large diameter will have to be larger than the length of a tubular chamber of small diameter. If a plurality of small tubular chambers are placed next to each other on a tray in a much smaller height, the same quantity of product of the desired quality is made as with a tray with one tubular chamber whose diameter has to be so much larger to obtain the same effective cross-sectional area.

In this connection it is of importance that the tubular contacting apparatuses should be placed on the tray as near as possible to each other. This makes special demands on the construction of the means for supply and discharge of liquid for each tubular chamber. These means for supply and discharge should preferably make it possible for two or more trays to be placed above each other because, for example in distillation, the operation must take place in several steps to enable the desired separation to be reached. The invention is concerned with the means by which the requirements made can be met in a simple way.

According to the invention a tray for mounting in a column for contacting liquids and gases has one or more tubular liquid-gas contacting apparatuses each mounted in or over an aperture in the tray and having spaced therefrom an enveloping tubular wall for the discharge of liquid from one end, of the apparatus, means for the discharge of gas being also provided at that end and means for the supply of liquid and gas being provided at the other end, and where within each

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apparatus the gas during the operation of the tray is in the continuous phase and one or more parts are located within each apparatus to impart rotary motion to the gas and the liquid. On the discharge end of the tubular contacting apparatus the liquid that has been separated from the gas flow is caught and is passed into the space between the two tubular walls. The width of the annular space between the two tubular walls can be adapted to the quantity of liquid to be processed.

It is advantageous for the enveloping tubular wall on the discharge end of the or a contacting apparatus to be longer than the tubular wall of the contacting apparatus, the protruding terminal end portion of the enveloping tubular wall being bent inwards, in such a way that the smallest diameter of the bent portion is equal to or smaller than the diameter of the contacting apparatus. As a result, the liquid to be discharged, which, owing to the rotary motion of the gas, moves over a brim of the discharge end of the contacting apparatus, is caught by the enveloping tubular chamber. Consequently there is no need of other means for catching the liquid.

The liquid being passed downwards in the annular space of a contacting apparatus must remain separated from the liquid to be supplied to that contacting apparatus, This can be achieved in a simple way by providing for the annular space to extend at least as far as the underside of the tray on which the tubular chamber in question is placed. In this connection it is advantageous for the space between the tubular contacting apparatus and the enveloping tubular wall on the supply end of the or a contacting apparatus to discharge into an annular drain which is located under the tray and through which drain the liquid discharge can be passed to a space located below the tray.

In order to prevent undesired effects resulting from a pressure difference between the two sides of the tray, such as, for instance, irregular discharge of liquid, it is, in addition, advantageous that a liquid seal is present in the annular drain.

Furthermore, for reasons of construction it is attractive if near the tray there are one or more connections between the space outside the enveloping tubular wall and the tubular contacting apparatus for the supply of liquid to the contacting apparatus. In that case the liquid to be supplied can be passed freely over the tray. Such a connection may consist of a pipe.

A connection as referred to above which from a constructional point of view is very simple is obtained by providing for the walls of the two tubular chambers to touch at the location of each connection by extrusion of the wall of the contacting apparatus and/or by indentation of the enveloping tubular wall, the connection being provided in the tangent plane. This method is advantageous particularly in the case of mass production of contacting apparatus of this type.

With the enveloping tubular wall according to the invention, which may, or may not, be provided with the above-mentioned complementary improvements, mounting of a plurality of tubular contacting apparatuses on a tray so that they are very close together is possible owing to the fact that it is possible to obtain complete, or almost complete, axial symmetry of the contacting apparatuses with means of supply and discharge, Still, if a small capacity is required, the use of a tray with only one contacting apparatus of this type is attractive in view of its simple construction.

The space between the enveloping tubular wall and the tubular contacting apparatus available for the discharge of liquid will not always all be required for that purpose. Part of that space may then serve for local enlargement of the cross-sectional area of the tubular contacting apparatus, namely by extrusions of the wall of the tubular contacting apparatus within the space between that contacting apparatus and the enveloping tubular wall. These extrusions may, for instance, run parallel to the axis of the tubular chamber. In this way the capacity is increased.

It may also be advantageous for the enveloping tubular wall to be provided with indentations within the space between that tubular wall and the tubular contacting apparatus. The tubular apparatus on a tray may then be placed more closely together, as a result of which the surface area of the tray may become smaller. Also, by this arrangement a larger space for the liquid to be supplied, may be created between the tubular apparatus, which in some cases may be desirable.

The connection between the space outside the enveloping tubular wall and the tubular contacting apparatus for the supply of liquid to the contacting apparatus may be combined with a space-saving extrusion or indentation as described above.

The tubular contacting apparatuses can be constructed of parts, for example by soldering, welding, folding or riveting. For the manufacture of parts use can be made of procedures such as punching, extrusion, deep drawings, casting, injection moulding.

Consequently, with trays provided with one or more tubular contacting apparatuses with enveloping tubular walls according to the invention it is possible for a column consisting of two or more trays placed above each other inside an enveloping wall to be built up in a simple way. In this connection it is an advantage that the tubular contacting apparatuses, which on each tray are located in corresponding places, are approximately in

line with each other. As a result of this, the liquid discharged from one contacting apparatus cannot fall into another contacting apparatus placed below it, which is very desirable. In addition, in this way it is possible for the gas leaving one contacting apparatus to reach another contacting apparatus placed above it with the minimum resistance.

The invention may be carried into practice in various ways but certain embodiments will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 represents a vertical cross-section of a tubular contacting apparatus, placed on a tray and provided with an enveloping tubular wall according to the invention;

Figure 2 represents a vertical cross-section of a similar tubular contacting apparatus with cross-sections of parts of adjacent contacting apparatuses each provided with an enveloping wall according to the invention;

Figure 3 and Figure 4 show vertical cross-sections and cross-sectional plans of tubular contacting apparatuses placed on a tray and provided with enveloping tubular walls according to the invention;

Figure 5 shows a cross-sectional plan and a longitudinal section of part of a column built up of trays on which are placed a number of contacting apparatuses provided with enveloping tubular walls according to the invention.

Figure 1 illustrates a contacting apperatus associated with a tray according to the invention. The tray 1 has upstanding therefrom a tubular wall 2 within which is located a vane deck 3. The gas enters the tubular wall 2 through an opening 4 at the lower end and between the opening 4 and the vane deck means may be provided, such as obstacles on the tubular wall, for atomizing liquid introduced via an inlet pipe 5 spaced above the tubular wall 2 are collars 6 by which liquid separated by the vane deck 3 is caught, this liquid passing into a space 7 surrounding the tubular wall 2 and formed by an enveloping tubular wall 8. This liquid passes down through the space 7 to an outlet pipe 9 by which the liquid may be transmitted elsewhere. The gas leaves the apparatus upwardly via an opening 10 formed by the inner of the two collars 6.

In an alternative arrangement shown in Figure 2 a similar tray 1 has a tubular wall 2 surrounded by an enveloping tubular wall 8. In this case the tubular wall 2 extends below the tray 1 and is provided at its lower end with a drain or weir 12 forming inner and outer recesses for liquid. Liquid flows into the outer recess via the space 7 and is guided into the recess by the lower terminal end portion 13 of the enveloping wall 8. The inner recess has extending into it the lower end of a tubular member forming the opening 4 leaving a slit 15 to provide access between the rising gas and the liquid to be contacted. In this arrangement liquid flows into the inner recess via an opening 14 situated approximately at the level of the tray 1.

The upper end of the enveloping wall 8 is inturned at 11 in order to catch the liquid separated by the vane deck 3. Figure 2 illustrates parts of associated contacting apparatuses and shows the manner in which these are related with one another.

In Figure 3 a further arrangement is shown which is somewhat similar to that of Figure 2 but in this case the liquid is supplied from the tray 1 via an opening 14 which is formed by an indentation of the wall 8. In this case the liquid supplied reaches the rising gases via openings 16 in a tubular member forming the opening 4. The plan cross section forming part of Figure 3 illustrates the four symmetrically disposed openings 14.

In the embodiment of Figure 4 the tubular member 2 is formed with outwardly extending portions 17 which contact the enveloping wall 8 at four points as indicated in the cross-sectional plan. In this case therefore the openings 14 are formed by two closely contacting portions of the walls 2 and 8.

Figure 5 gives by means of a plan cross-section and a vertical cross-section, a diagrammatical illustration of the combination of a plurality of contacting apparatuses into a column 18. The contacting apparatuses, which on each tray occupy corresponding positions, are placed in line with each other. The liquid flowing down through the spaces 8 passes the tray 1 and leaves those spaces via the drains 12 and further falls down, along the tubular chambers, to the tray lying below, after which that liquid reaches the contacting apparatuses on that tray via the openings 14. The gas passes through the various contacting apparatuses being located above each other from below upwards.

WHAT WE CLAIM IS:—

1. A tray for mounting in a column for contacting liquids and gases having one or more tubular liquid-gas contacting apparatuses each mounted in or over an aperture in the tray and having spaced therefrom an enveloping tubular wall for the discharge of liquid from one end of the apparatus, means for the discharge of gas being also provided at that end and means for the supply of liquid and gas being provided at the other end, and where within each apparatus the gas during the operation of the tray is in the continuous phase and one or more parts are located within each apparatus to impart rotary motion to the gas and the liquid.

2. A tray according to Claim 1, in which the enveloping tubular wall on the discharge end of the or a contacting apparatus is longer than the tubular wall of the contacting

apparatus, the protruding terminal end portion of the enveloping tubular wall being bent inwards in such a way that the smallest diameter of the bent portion is equal to or smaller than the diameter of the contacting apparatus.

3. A tray according to Claim 1 or 2, in which the space between the tubular contacting apparatus and the enveloping tubular wall on the supply end of the or a contacting apparatus discharges into an annular drain which is located under the tray and through which drain the liquid discharged can be passed to a space located below the tray.

4. A tray according to Claim 3, in which a liquid seal is present in the annular drain.

5. A tray according to any one of Claims 1 to 4, in which there are one or more connections near the tray between the space outside the enveloping tubular wall and the tubular contacting apparatus for the supply of liquid to the contacting apparatus.

6. A tray according to Claim 5, in which at the location of each connection the two tubular walls touch each other by extrusion of the wall of the contacting apparatus and/or by indentation of the enveloping tubular wall.

7. A tray according to any one of Claim 1 to 6, characterized in that the cross-sectiona area of the tubular contacting apparatus ha been locally enlarged by extrusions of the wa of the tubular contacting apparatus withi the space between that contacting apparatu and the enveloping tubular wall.

8. A tray according to any one of Claim 1 to 7, characterized in that the envelopin tubular wall is provided with indentation within the space between that tubular wa and the tubular contacting apparatus.

9. A column consisting of two or more tray according to any one of Claims 1 to 8, place above each other inside an enveloping wall.

10. A column according to Claim 9, charac terized in that the tubular contactin apparatuses, which on each tray are locate in corresponding places, are approximatel in line with each other.

11. A tray or column for contacting liquid substantially as described in the foregoing an elucidated in the drawings.

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3 SHEETS This drawing is a reproduction of the Original on a reduced scale.
Sheet 1

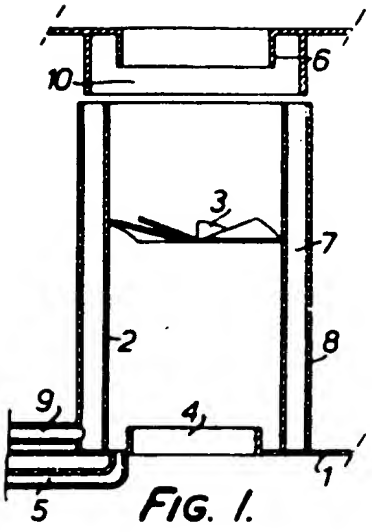

FIG. 1.

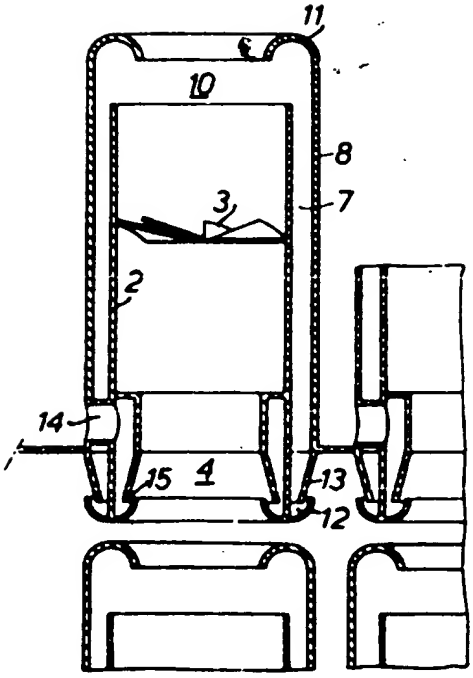

FIG. 2.

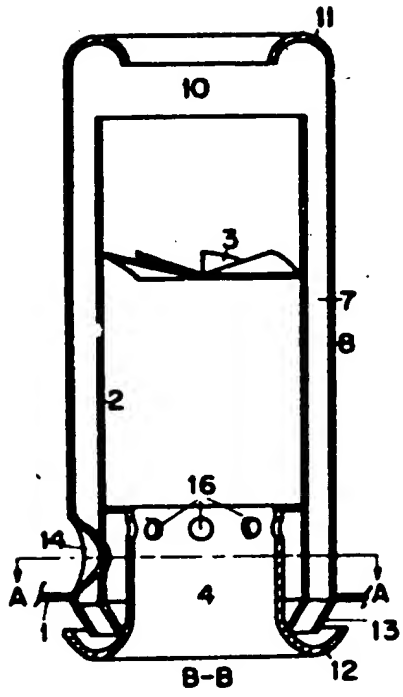

FIG. 3

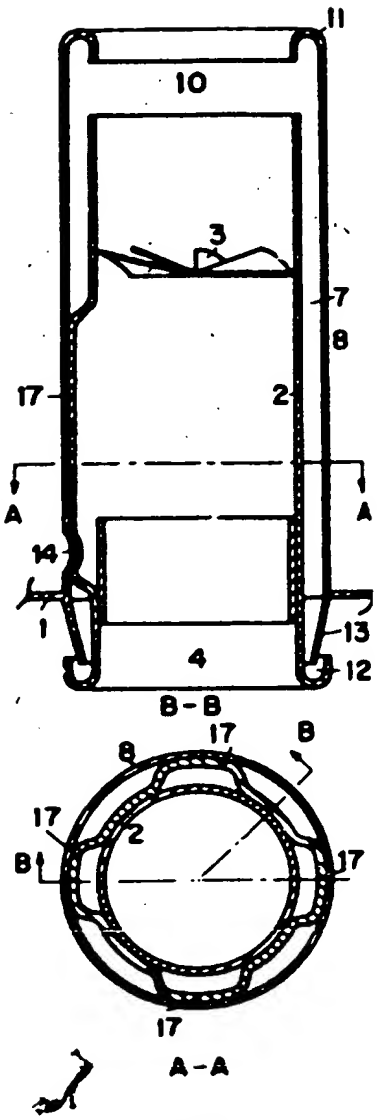

FIG. 4

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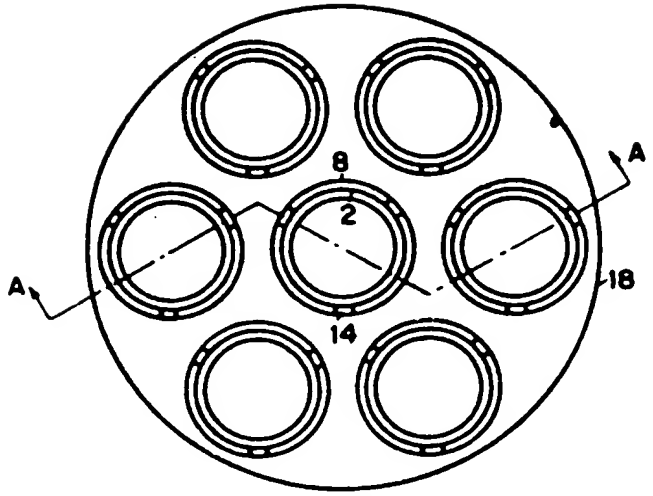
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 2 & 3



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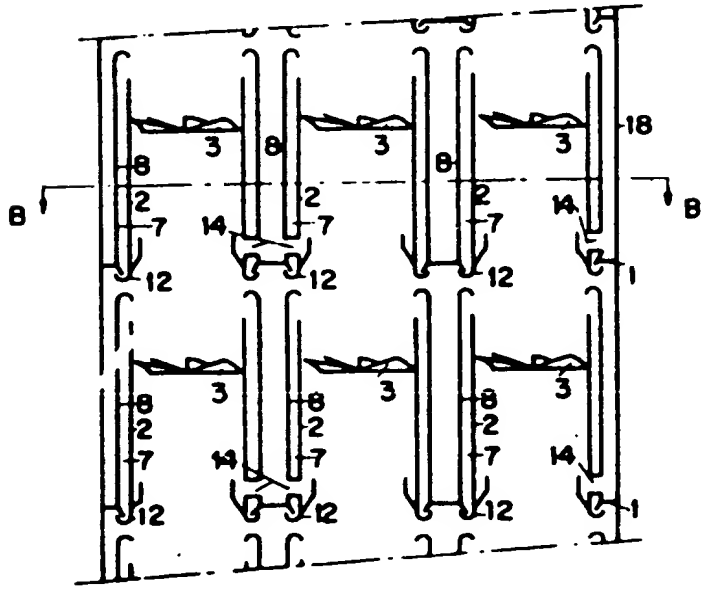

A - A

FIG. 5